

SW06 Shallow Water Acoustics Experiment

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LONG TERM GOALS

The long term goal of our shallow water acoustics work is to understand the nature of low frequency (10-1500 Hz) acoustic propagation and scattering in shallow water when strong oceanic variability in the form of fronts, eddies, boundary layers, and internal waves is present. To achieve this goal, we participated in a scientifically sound and Navy relevant basic research experiment in shallow water acoustics, concentrating on both low and medium frequencies.

OBJECTIVES

Our primary objective this year was to perform analysis of the vast data set collected by the experiment. A secondary objective was to continue some of our other ongoing analyses in shallow water acoustics, both in data analysis and theory.

APPROACH

In performing the data analysis, we have concentrated in the past year in calibrating the data, doing positioning and timing of acoustic source/receiver systems, reducing the data to a useful form (e.g. performing cross correlations on m-sequence transmissions), documenting the large amount of work done in this “preparatory phase” of the analysis, disseminating the data to various investigators, maintaining a web site for the project, and coordinating efforts to analyze and publish the data.

WORK COMPLETED/ACCOMPLISHMENTS

Given the very successful execution of the SW06 experiment, we were then faced with the large but pleasant task of analyzing ~10 TByte of data of various sorts. We put a large amount of effort into turning raw data, like the SHRU data shown in Figure 1, into processed data like the modal arrival time structures shown in Figure 2. The results of this data processing have been reported in a WHOI Technical Report, which should be a very useful document for all the PI's (inside and outside WHOI) who will be working with the SW06 data set. We have already produced some beginning papers on the data analyses (see below), and are aiming to have a series of 7-10 papers additional submitted to a JASA-EL Special Issue at the end of 2007.

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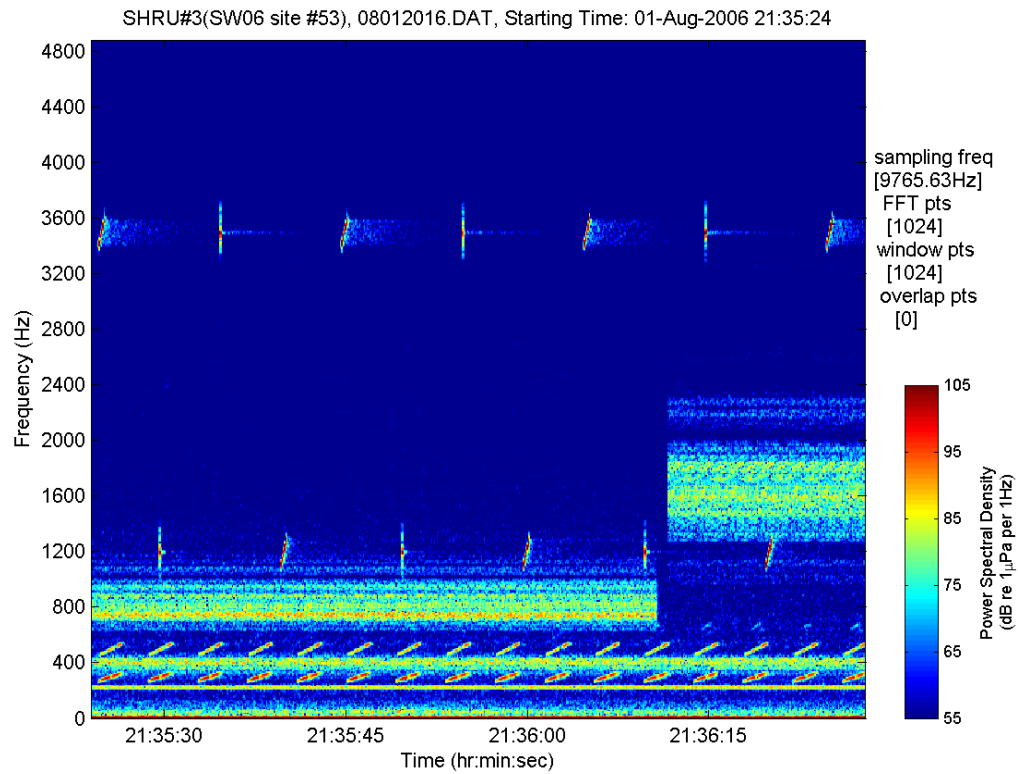


Figure 1. SHRU data from SW06, showing receptions from 224 Hz, 300 Hz, 400 Hz, 500 Hz, 800 Hz, and 1600 Hz moored sources, and 1200 Hz and 3600 Hz A-Comms signals sent from a shipboard source.

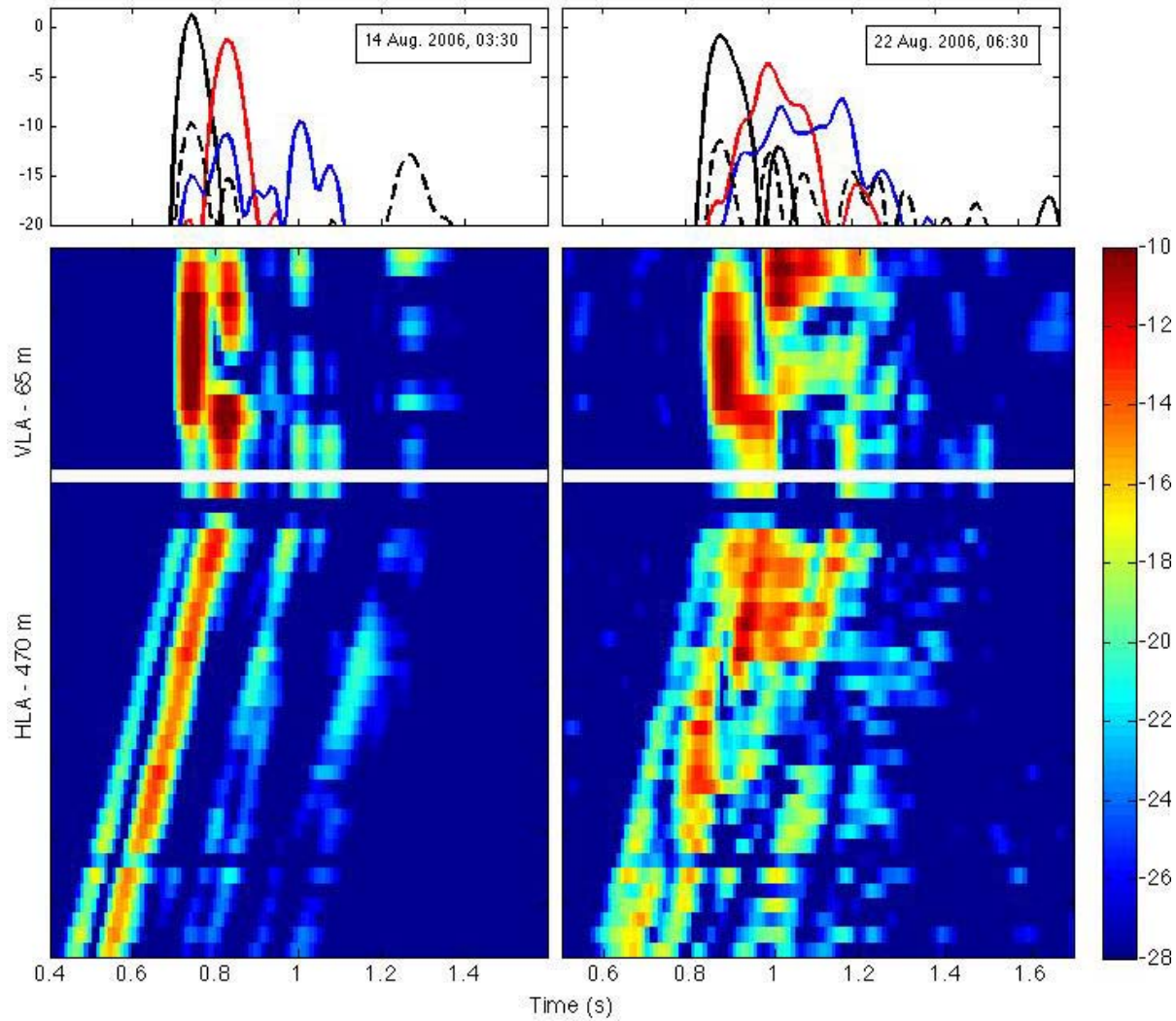


Figure 2. Processed data from the WHOI HLA/VLA showing normal mode arrivals during two periods – one without high internal wave activity present (left panels) and one with high internal wave activity (right panels). The scattering of the higher mode acoustic arrivals by the internal waves is clearly evident.

We also worked on a number of other shallow water acoustics topics this past year, in addition to SW06. These were: 1) ducting of acoustic energy between internal waves in shallow water, 2) a book chapter on geoacoustic inversion techniques, 3) studies of the uncertainty in bottom inversions due to water column uncertainty, 4) a book chapter on nonlinear internal waves and acoustics, and 5) our book on shallow water acoustics. This work has resulted in a number of publications as cited below.

RESULTS

There are a large number of results that are coming out from our work, both on SW06 and other shallow water projects. Two of the most intriguing to us are: 1) developing a formalism (data nullspace projection) that allows us to project “noisy” data out of a data set, and thus use cleaner data for inversions, source localization, etc. and 2) obtaining and beginning the analysis of two data sets that

will allow us to see directly the azimuthal dependence of propagation (i.e. TL) in a shallow water environment.

IMPACT/APPLICATIONS

The impact of our experiment should be: 1) an increased understanding of the propagation of sound through complicated coastal oceanography, 2) a better understanding of how to incorporate “uncertainty” in the ocean state into sonar performance measures, and 3) an improved use of AUV’s in doing acoustic missions in coastal regions, eventually giving the Navy a “robotic forward area presence.”

TRANSITIONS

One eventual transition of our data will be to ONR’s Uncertainty DRI program, where the interest is in “the error bars” in ocean acoustic field and system performance prediction. We also hope to have our REMUS acoustic towed array technology transitioned to operational use in the future.

RELATED PROJECTS

The SWARM acoustics/internal wave study, the PRIMER acoustics/shelfbreak front study, and ASIAEX were direct predecessors of SW06, and examined some of the same acoustic scientific issues, only with far fewer measurement resources. The “Non-linear internal waves initiative” (NLIWI) is strongly related to our SW06 LEAR effort via the environmental support that the oceanographic moorings (and other PO measurements) provided. The SW06 experiment also had an AWACS component, stressing the use of acoustics on AUV’s and gliders, and also adaptive sampling. The upcoming QPE experiment, stressing acoustic and environmental Uncertainty in a coastal environment, is also related.

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